

Stegodonts and the Dating of Stone Tool Assemblages in Island Southeast Asia

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KNOWLEDGE OF Southeast Asian prehistory until recently was organized into a system of stages rigidly defined in terms of artifact technology, human type, and geological epoch. The fit between human types, artifacts, and geological ages was thought to be so close that a find of any diagnostic artifact type or fossil was sufficient to automatically decide the chronological age and technological period as well (see Table 1).

The results of archaeological surveys by Bartstra (1978*a*, 1978*b*, 1982) and Bartstra et al. (1976, 1988) have shaken belief in the association of *Homo erectus* with Pacitanian-like large-core tool industries. Similarly the appropriateness of the terms *Mesolithic* and *Palaeolithic* for Southeast Asia has been questioned (cf. Hutterer 1977). Despite these new results, however, the older interpretive framework of a close connection between geological age, human type, and technological stage has simply been replaced by a revised version (Table 2).

Foley (1987) has argued that covariation between hominid fossil morphology and artifact variability is an essential starting point for understanding the evolution of human behavior. Without denying the eventual demonstration of such a covariation, it must be stated that premature conclusions along these lines have proved damaging for Southeast Asian archaeology. In any case, in Southeast Asia conclusions about relationships between technology and hominid type are bedeviled by a lack of consensus about the taxonomic status of certain of the fossils, in particular the Ngandong crania.

The taxonomic relationships of the Asian and Australian hominid fossils are currently under debate. There is consensus that the Sangiran fossils (Sangiran 2, 3, 10, 12, 17, and 38), which date to the Middle Pleistocene (400–800 ka), are classic Pithecanthropus *Homo erectus* (Semah et al. 1990:63). On the other hand, the Upper Pleistocene Niah, Wajak, Mungo, and Kow Swamp hominids are accepted as fully *Homo sapiens* (Wolpoff et al. 1984:436–446).

The contested ground concerns the nature of the changeover from *H. erectus* to *H.*

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TABLE 1. HYPOTHETICAL STAGES OF HUMAN AND TECHNOLOGICAL DEVELOPMENT IN SOUTHEAST ASIA (AFTER MOVIUS 1955, VAN HECKEREN 1972)

GEOLOGICAL EPOCH	ARCHAEOLOGICAL PERIOD	HUMAN TYPE	ARTIFACTS
Recent Holocene	Neolithic Mesolithic	Indo-Malaysian Australo- Melanesoids	Pottery, adzes Tolean points and micro- liths, Sampung bone and stone points, Hoabinhian pebble tools
Upper Pleistocene	Upper Palaeolithic	Wajak, <i>Homo sa- piens</i>	Flake implements
Middle or Upper Pleistocene		Solo or Ngan- dong fossils(?)	Flake implements from Ngandong, Sangiran, Cabenge
Middle Pleistocene	Lower Palaeolithic	Java Man, <i>Homo erectus</i>	Pacitanian hand axes

TABLE 2. REVISED HYPOTHETICAL STAGES OF HUMAN AND TECHNOLOGICAL DEVELOPMENT IN SOUTHEAST ASIA (AFTER BELLWOOD 1985 AND BARTSTRA ET AL. 1988)

GEOLOGICAL EPOCH	ARCHAEOLOGICAL PERIOD	HUMAN TYPE	ARTIFACTS
Recent Holocene	Neolithic	Indo-Malaysian, Mongoloid Australoid	Pottery, adzes Flake and blade technocom- plex (Toalian, Sampung), Hoabinhian
Upper Pleistocene		Wajak (Austra- loid) popula- tion, <i>Homo sa- piens</i>	Pebble and flake tech- nocomplex
Upper Pleistocene		Solo or Ngan- dong fossils	Small flake artifacts, Ngandong and Sangiran
Middle Pleistocene		Java Man, <i>Homo erectus</i>	No artifacts yet recovered

sapiens, whether replacement or regional continuity (Stringer 1990; Wolpoff et al. 1984). The Ngandong fossils are variously regarded as an evolved, but terminal, phase of *H. erectus* and called *H. e. solensis* (Bartstra and Basoeki 1989:241; Semah et al. 1990:67), or else as an ancestor to some of the Pleistocene Australians (Wolpoff et al. 1984:446-447). The uncertainty as to whether these fossils belong to *H. erectus* or *H. sapiens*, or somewhere in between, will be avoided here by using the term *Ngandong fossils* to describe them.

Whatever the merits of the claims for the Northern Hemisphere, the dating and understanding of the Southeast Asian hominid fossils and stone tool assemblages must be considerably advanced before claims of covariation between them can be pursued. The purpose of this paper is to clarify some of the dating and technological issues surrounding the stone tool assemblages of Southeast Asia. To make headway with these questions it is necessary, now and in the immediate future, to proceed

independently of decisions about the taxonomic status of the hominid fossils and any possible covariance between hominid type and technological stages.

Of particular interest to the question of technology and dating is the claimed association of Middle Pleistocene *Stegodon* fossils with stone tools east of Huxley's Line.

The association of stone tools with Stegodont faunas in Island Southeast Asia has been claimed for the Philippines (Fox 1978:69–79), Sulawesi (van Heekeren 1958:77–79), and the islands of Eastern Nusatenggara, Flores, and Timor (Glover and Glover 1970:189; Maringer and Verhoeven 1975:104). The association of the Stegodonts with Pacitanian-like flake and pebble tools on these islands has been used as evidence that *Homo erectus* crossed the sea barriers of Wallacea during the Middle Pleistocene.

Van Heekeren (1972:71–72) concluded that “if one thing has become clear it is that there is no Wallace Line . . . , either at present or in the past. . . . Early Man. . . . and even Proboscideans crossed the so-called Wallace Line in one way or another.”

In noting the presence of Pacitanian-like assemblages in gravel deposits on Flores and Timor, Mulvaney (1970:186) stressed their significance for Australian archaeology: “If it is identified as Patjitanian, it lies across the Wallace Line from its type-site. This would show that its makers crossed deep water. . . . yet, if *H. erectus* possessed any watercraft at all, he possessed the potential to reach Australia.”

PROBOSCIDEA IN ISLAND SOUTHEAST ASIA

A number of genera belonging to the Order Proboscidea have been identified in deposits from Island Southeast Asia. These include *Stegolophodon*, *Elephas*, and *Stegodon* (Simpson 1977:111).

Stegodon was so common in the Middle Pleistocene fauna of South China that it has lent its name to the distinctive *Ailuropoda-Stegodon* fauna identified for the region at that time. *Stegolophodon* was also present but rare in this fauna. De Vos and Sondaar (1982:48, 51) note the presence of *Stegodon* and *Elephas* in the Middle Pleistocene fauna of Java.

Within Island Southeast Asia, fossil evidence for large or “continental-sized” species of Proboscidea often occurs in association with fossils of pygmy or dwarfed species. This is true for both *Elephas* and *Stegodon* species (Hooijer 1975:38, 41). An association of a large with a pygmy form of *Stegodon* has been noted for Sulawesi, Flores, Timor, Luzon, and Mindanao. This dwarfing process is regarded as the product of extreme selective pressure in the remote insular situation during the Quaternary (Medway 1972:66). Groves (1985:49) also notes the presence of different species of dwarf “buffaloes” on Sulawesi and in the Philippines (Mindoro and Luzon). On the other hand, some genera on islands, particularly reptiles, experienced giantism, for example, the giant land tortoises and the Komodo lizard *Varanus komodoensis* (Sondaar 1981:116).

The taxonomy of the Stegodonts and our knowledge of the distribution of these species on the islands of Wallacea remains confused. There are competing hypotheses regarding founder populations and their mode of migration to different islands. Whether species are lumped together or split up depends on which theory is ascribed to.

TABLE 3. PROBOSCIDEA FOSSILS IN ISLAND SOUTHEAST ASIA

LOCATION	FOSSIL
Java	<i>Trilophodon (Mastodon) bumiajuensis</i> <i>Elephas (Archidiskodon) planifrons</i> (L) <i>Elephas hysudrindicus</i> <i>Stegodon trigonocephalus</i> (L) <i>Stegodon hypsilophus</i> = <i>Elephas celebensis</i> Hooijer (= <i>Stegodon trigonocephalus</i> ? [de Vos and Sondaar 1982:51])
Borneo	<i>Stegolophodon latidens</i> <i>Elephas namadicus</i> (L)
Sulawesi	<i>Stegodon trigonocephalus</i> (L) <i>Stegodon sompoensis</i> (S) <i>Elephas (Archidiskodon) celebensis</i> (S) (derived from <i>E. planifrons</i> [Groves 1985:51])
Flores	<i>Stegodon trigonocephalus florensis</i> (L) <i>Stegodon sompoensis</i> (S) (= <i>S. sumbaensis</i> Sartono)
Timor	<i>Stegodon trigonocephalus</i> (L) <i>Stegodon sompoensis</i> (= <i>S. timorensis</i> [Sartono 1979a]) (S)
Sumba	<i>Stegodon sompoensis</i> (S) (= <i>S. sumbaensis</i> Sartono [but see Hooijer 1981]) (S)
Luzon	<i>Stegodon trigonocephalus</i> (L) <i>Stegodon luzonensis</i> (S) <i>Elephas beyeri</i> (S?) (cf. <i>E. namadicus</i> [Groves 1985:52])
Mindanao	<i>Stegodon cf. trigonocephalus</i> (L) <i>Stegodon mindanensis</i> (S)

Note: L = large form; S = smaller form.

Hooijer (1975) favors the idea of a land bridge in the past between Sulawesi and Flores-Timor, and a single breeding population existing in this "Stegoland." This breeding population was subsequently isolated on separate islands by tectonic and eustatic changes. Consequently he describes the larger fossil forms on these islands as all belonging to *Stegodon trigonocephalus* and all the pygmy forms as *Stegodon sompoensis*, with the larger form the ancestor of the smaller.

By contrast Sondaar (1981) favors an overseas (swimming) dispersal mechanism, by which the large form *S. trigonocephalus* reached Sulawesi, Flores, Timor, Sumba, Luzon, and Mindanao. Selective pressures unique to each island were then responsible for the development of different species of the pygmy stegodonts. "Since for the moment there are no valid arguments for including all the small elephants [*sic*] of Sulawesi, Flores and Timor in the same species . . . it is much more reasonable to suppose that the species are different on each island and that they evolved in geographical isolation" (Sondaar 1981:115-116).

The fossils and geographical localities are listed in Table 3 (after Simpson 1977).

Simpson (1977:112-113) points out that there are no Proboscideans today east of Huxley's Line, and as far as is known none have been there since the Pleistocene. On the other hand, large Stegodonts (and even true elephants, genus *Elephas*, on Sulawesi and Mindanao) are ubiquitous wherever Pleistocene fossil mammals occur.

Notwithstanding the possibility of a Borneo-Palawan connection, Heany (1985:137, 141) concluded that there was no faunal evidence for a land bridge be-

tween the Asian mainland and the Philippines. Proboscideans are strong swimmers; therefore, their presence on islands is not proof of a land connection.

As noted previously, even in areas known to have been connected by land bridges, such as the islands that formed Sundaland, a high degree of endemism prevailed. This suggests that drainage channels, vegetation, and tectonic movements created barriers to dispersal throughout the Pleistocene (Groves 1985:43–46).

DATING THE STEGODONS

Until now the dating of the *Stegodon* fossils and sediments has depended on stratigraphy and associated faunas, particularly the presence of the giant land tortoise *Geochelone* (= *Testudo margae*) on Java, Sulawesi, and Timor. *Geochelone* was widespread in both the Old and New World during the Tertiary and Pleistocene but today survives only on islands such as the Galapagos (Hooijer 1982:171).

There is agreement that the tortoises in question reached the islands of Wallacea through overseas dispersal. There is less agreement over their specific identity and age. Hooijer (1982) claims that all are conspecific with *Geochelone atlas* from the Late Pliocene or Early Pleistocene Siwalik fauna of northern India. In Java, the Kali Glagah fauna, with *Geochelone* present, is Late Pliocene in age, and Hooijer links the *Geochelone* and *Stegodon* faunas of Sulawesi and Timor to that time also.

Hooijer (1982:173) comments, "Since the *Geochelone* as well as the *Stegodon* of Timor . . . are the same as those of Sulawesi the Timor *Geochelone-Stegodon* fauna may be taken to be of the same age as that from Sulawesi, i.e. Late Pliocene. The age differences between the Sulawesi and Timor *Geochelone* on the one hand, and the Siwalik and Java *Geochelone* on the other, then, are non-existent."

Sondaar (1981:116–117), on the other hand, argues that *Geochelone* in Java, Timor, and Sulawesi are different species representing geographically isolated evolution. Noting that *Geochelone* exists to the present day on the Galapagos Islands as a diversity of species, he suggests (1981:117) that the faunas on Sulawesi and Timor were there during the Middle and Upper Pleistocene, rather than the Lower Pleistocene, as claimed by Hooijer.

The physical evolution of the Cagayan Valley on Northern Luzon in the Philippines has been reviewed by Wasson and Cochrane (1979). They concluded that the fossils on the valley surface, which include *Elephas*, *Stegodon*, and *Bubalus*, derived from the Upper Ilagan and Awidon Mesa Formations, date stratigraphically to the Middle Pleistocene (Wasson and Cochrane 1979:22).

The fossil-bearing sediments at Cabenge, South Sulawesi (containing an *Elephas-Stegodon-Celebochoerus* fauna in the Walanae formation), are Pliocene, i.e., 3–4.6 ma (Bartstra 1978a:71–72; Sartono 1979b:65–81).

Elsewhere in Indonesia, the upper terrace on the Solo River at Ngandong, Java, is of particular interest, for only in this terrace have hominid fossils, stone artifacts, and Pleistocene fauna (*Stegodon trigonocephalus* and *Elephas hysudrindicus* [Medway 1972:80]) been recovered from the same stratigraphic unit, though not in direct association. Ngandong was one of the faunal/stratigraphic units proposed by von Koenigswald in his Jetis (Lower Middle Pleistocene), Trinil (Middle Pleistocene), Ngandong (Upper Pleistocene) sequence (Shutler and Braches 1985:91–95).

Whether the claimed faunal differences between the Middle Pleistocene Jetis and Trinil beds have any basis in reality, or are due to sampling error, has been under

question since 1952 (Groves 1985:47–48). Similar doubts have been raised about the differences between the Ngandong and Trinil beds. These question the Upper Pleistocene status of the Ngandong sediments and fauna. Medway (1972:65) comments that of the extinct species on Java, “those remaining into the Upper Pleistocene, but subsequently disappearing, included among the NGANDONG fauna the large ‘tiger’ *Panthera palaeojavanica*, the common Javanese stegodont *S. trigonocephalus* and the hippopotamus *H. sivalensis*, another apparent member of this group, the large ox *Bos palaeosondaicus*, was probably the direct ancestor of the modern banteng *B. javanicus*.”

Of the 17 species recorded among the animal bones from Ngandong, 12 or 13 are shared with the Trinil fauna (62 species). Only the pig and deer are modern forms. On the other hand, the only extinct genus is the *Stegodon* (Bellwood 1985:52).

Jacob (1978) and Bellwood (1985:53) use the similarities between the Ngandong and the supposedly much older Trinil fauna to argue that the Ngandong hominids date to the Late Middle Pleistocene. Recent advances in dating, however, suggest a much younger age.

Bartstra et al. (1988:325–337) have reviewed the evidence relating to Ngandong Man. In the light of their own recent field studies, they concluded that the Solo High Terrace, the associated inconspicuous small chalcedony flakes and cores, and the hominid fossils belong to the first half of the Upper Pleistocene rather than the Middle Pleistocene. An Upper Pleistocene dating of *Stegodon* in Java complements similar Upper Pleistocene dates for *Stegodon* fossils reported from Viet Nam (Hoang Xuan Chinh 1990) and Southeast China (Aigner 1978:136–137; Zhang Yinyun 1990).

Clearly the *Geochelone-Stegodon* faunas of Wallacea may date from the Pliocene right through to the Upper Pleistocene. Associations between *Stegodons* and human artifacts are not a guarantee of a Middle Pleistocene age.

Glover (1973a:54) notes, “The Upper Pleistocene fauna is almost entirely modern, that is composed of still living species, except for *Stegodon*, which seems to have survived longer in Java and the Lesser Sunda Islands than elsewhere.”

The survival of *Stegodon* on Mainland Asia and Island Southeast Asia until the Upper Pleistocene raises questions about its eventual extinction.

Medway has commented at length about mammalian extinctions:

Throughout the world, the final phase of the Pleistocene was characterised by widespread extinctions among mammals. Unlike the extinctions of earlier transition periods, these were not matched by compensatory evolution of new forms. . . .

In Malesia it appears the loss of mammals was less catastrophic than elsewhere. . . . Comparison of Malesian faunas of Middle and Upper Pleistocene dates with those of the present time shows only 11 generic extinctions in the region.

It is clear that these extinctions occurred not *en bloc*, but successively throughout the period, preceded by recessions of range. Some species of the Middle Pleistocene survived longer than others. (Medway 1972:65)

Middle Pleistocene mammals in Malesia, Medway (1972:70) argues, were browsing or grazing animals, which depended on a diverse mosaic of vegetation forms ranging from evergreen forest and scrub to grassland. He identifies *Stegodon trigonocephalus* as a browser and the pygmy *Stegodon hypsilophus* as adapted to a diet of bamboo and grass. The extinctions, he argues, were caused by an increase in the extent of climax rainforest and a reduction of floral diversity. Such an explanation on its own cannot account for the *Stegodon* extinctions on the islands of Nusatenggara,

which retained a strongly seasonal climate and a mosaic of woodland and grassland vegetation communities, presumably throughout the Pleistocene.

The advantages islands have as isolated refugia is offset, however, by the disadvantages of small size and limited ecosystem variability. The vegetation and faunas of small islands are particularly vulnerable to the vagaries of environmental change and chance. They would also be at risk when humans arrived on these islands for the first time. Sondaar and Dermitzakis (1988:195) interpret the extinction of *Stegodon* and *Geochelone* on Flores as the result of human predation.

PLEISTOCENE STONE TOOL ASSEMBLAGES: REINTERPRETING THE FIELD EVIDENCE

The dating and association of the supposed Middle and Late Pleistocene stone tool assemblages and questions about their association with the extinct fossil faunas have been reviewed by Bellwood (1985:60–66, 1987:186), Hutterer (1985:11–12), and Jones (1989:746–754). However, in all these cases, the coverage and conclusions drawn are brief. Jones (1989) concentrates on the Australian data. The discussion of the evidence from Island Southeast Asia presented below allows assessment of hypotheses relevant to both Wallacea and Australia.

Java

SANGIRAN

Bartstra (1978b:69) has reported that, thus far, no securely provenanced, definite stone artifacts have been recovered from the Middle Pleistocene beds at Sangiran. While small flakes and cores occur in the Upper Pleistocene gravel veneers that cap the surrounding hills, the stone materials from the deeper lying sediments consist of a mass of undefinable fragments that resemble eoliths or pseudo-artifacts. Bartstra (1978b:69) concludes that “it remains a fact, however, that this Middle Pleistocene industry has yet to be discovered at Sangiran.”

The very top gravel of the Ngebung hills, located on the northwestern rim of Sangiran, has been labeled the Old River Gravel and dated to the beginning of the Pleistocene (Bartstra and Basoeki 1989:241). These gravels contain many small (< 5 cm) chalcedony flakes and cores. Bartstra and Basoeki (1989:242) argue that the Old River Gravel is equivalent in age and stratigraphy to the Solo High Terrace system.

Large-core tools made from andesitic rocks have also been recovered from the Sangiran area. At Ngebung these are associated with the Late Pleistocene, Young River Gravel.

NGANDONG

In situ Ngandong vertebrate fossils have been dated by $^{230}\text{Th}/^{234}\text{U}$ analysis to the period 30,000–100,000 B.P. Bartstra et al. (1988:325–337) claim that this is also the age of the Ngandong hominid fossils and the small stone flakes, cores, and occasional flaked pebbles that come from the Solo High Terrace.

SAMBUNGMACAN

The initial discoverers of the Sambungmacan cranium identified its stratigraphic position as being in sediments belonging to the Puncangan formation. Consequently they assigned it a Lower Middle Pleistocene age. Later field examination of the fossil

beds at Sambungmacan also revealed two stone artifacts manufactured from cobbles of basaltic andesite. These consisted of, first, a large retouched flake, and second, a split cobble showing multiple negative flake scars. The artifacts were partially exposed in a section of a natural alluvial channel described as being "still embedded in the top of a fossiliferous gravel bed" (Jacob et al. 1978:885).

Sambungmacan was originally thought to be a site that showed the long looked-for association of *H. erectus* with stone tools (Bellwood 1985:65). In subsequent discussions, Sartono (1979c:83–88) has questioned the stratigraphic identification of the fossil-bearing deposit, concluding that the terrace deposit was Upper Pleistocene in age. As for the stone tools, Bartstra (1982:319) comments that "the chopper and flake, which are not abraded, but very fresh-looking, are contemporaneous with these terrace deposits, they are certainly not Middle Pleistocene. . . it must be said that on Java there is still not a single site where artifacts can be associated with *H. erectus*."

THE PACITANIAN

The Pacitanian assemblage was initially described as containing implements made from large, sometimes massive, flakes with jagged or undulating worked edges and little secondary retouch; core tools with alternatively flaked edges made on water-worn pebbles; and some "proto hand-axes" (Movius 1955:524–525). In a corrective report, Mulvaney (1970:184–187) emphasized that the majority of artifacts were made from flakes rather than from cores.

The artifacts have been collected from a variety of locations over the last 50 years. These include gravel terraces, valley slopes, and plateau surfaces, all beside the Baksoka River in South Central Java.

The assumption that the artifacts were of Middle Pleistocene age, and therefore could be associated with *Homo erectus*, has been questioned by Bartstra (1976, 1978b, 1982). Bartstra (1978b:65) noted that the large-core tools could be found on workshop sites in the hills away from the river, alongside specifically neolithic types. By 1982, Bartstra accepted that the oldest river terraces of the Baksoka belonged to the final phases of the Pleistocene: "These artefacts. . . cannot be the work of *H. erectus erectus*. . . Wadjak man could very well have been the manufacturer of the patjitanian tools, and the very name "patjitanian" can be cast into the melting pot of the Hoabinhian" (319).

Bartstra's conclusions echo those of van Heekeren that "these industries. . . that have been classified as palaeolithic may prove on absolute dating to be mesolithic or more precisely to be Hoabinhian" (1972:47).

The status of the Pacitanian is the subject of a comment by Hutterer: "The various collections labelled 'Patjitanian' are not only not securely located in space and time, they do not even provide a sound basis for a purely technological assessment of the industry, if indeed they all relate to a single industry or lithic tradition" (1977:40).

Sulawesi

The Cabenge flake assemblage was first obtained by van Heekeren in 1946 from terraces beside the Walanae River in South Sulawesi. The artifacts consisted of short thick flakes with a clearly defined bulb of percussion made from glossy yellow chal-

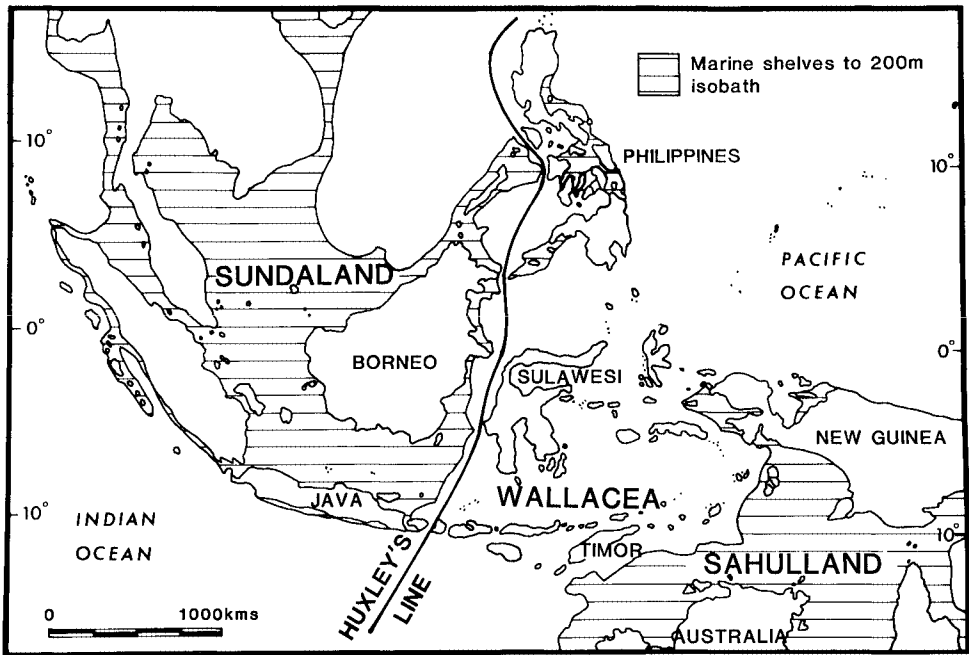


Fig. 1. The Indo-Malaysian Region during the Pleistocene, showing Huxley's Line and major biogeographical regions. (After Bellwood 1985.)

cedony, red jasper, and other siliceous rocks (van Heekeren 1958:78). Retouched artifacts were rare.

Although van Heekeren was cautious, he nonetheless suggested that the tools were lower Palaeolithic in nature, and on the basis of the association with the *Elephas-Celebochoerus* fauna he assigned a Late Middle Pleistocene age (van Heekeren 1972:71).

The Walanae terraces were revisited by Bartstra in 1978. He distinguished "Clactonian" flakes in the high terrace gravels, flakes and cores on other terraces, and finally small flakes and cores alongside hollow-based denticulated spearheads on high spots alongside the river (Bartstra 1978a:71). The vertebrate fossils, however, could not be associated with the stone artifacts. Sartono (1979b:72, 78) accepts that the *Elephas-Celebochoerus* are Pliocene in age, but argues that the artifacts in the Walanae terraces are of Pleistocene age (Sartono 1987:199).

Excavations by Glover at Leang Burung 2 rockshelter near Maros in South Sulawesi demonstrate human occupation there between 19,000 and 31,000 B.P. (Glover 1981:16). Glover uses Bartstra's (1978:71-72) conclusions, and the supposed differences between the Leang Burung 2 artifacts (particularly Levallois point production) and those at Walanae to argue that "if man had a hand in the extinction of Sulawesi's stegodonts (as I believe is likely) this took place at a much earlier time. By implication, the oldest assemblage of heavily rounded and patinated 'Clactonian' flakes in the high terraces of the Walanae River . . . are considerably older than 30,000 years, for nothing of this description was found at Leang Burung 2" (Glover 1981:37).

Perhaps it is best to follow Bellwood's lead, who maintains that "the tools from Cabenge . . . can only be presumed to be of indeterminate Pleistocene age" (Bellwood 1987:186).

Eastern Nusatenggara

FLORES

There is considerable confusion about the status of the stone artifacts collected by Maringer and Verhoeven (1970a, 1970b, 1972, 1975) at a number of localities (Mengeruda, Waiklau River, Marokoak) in Northern Central Flores. The artifacts consist of large flaked pebbles and numerous large retouched flakes. The central question is the association of these artifacts with the *Stegodon* fossils. Glover (1973b:123) reports

At least 74 artefacts were found *in situ* in the fossil-bearing levels at Mengeruda, and a further 158 surface finds were thought to be derived from the same horizon. . . . The majority of the implements were made on flakes . . . which are usually rather thick and short with plain platforms. . . . The proportion of pebble tools is surprisingly low, about 6%, . . . and, in addition, there are a few parallel-sided, blade-like forms; although the few cores show no signs of true blade manufacture. . . . There is a possibility, . . . that two separate traditions are represented in the Flores collections, the one Middle and the other Upper Palaeolithic.

Van Heekeren has made similar observations:

In recent years . . . fossil bones of *Stegodon*, Giant Tortoise, crocodiles and rodents [have been discovered] in tuff and sandstone beds on the left side of a dry water-course in West Central Flores. The fossil bearing deposits also contained stone artifacts, mainly flake-tools and a few small pebble-tools, 5–6 cm long. . . . The sites . . . are all situated on the Soa Plateau, 500 m above sea-level. A Late Middle Pleistocene age for the fossil-artifact bearing layer was suggested. (van Heekeren 1972:71)

Human predation during the Middle Pleistocene was thought to be responsible for the extinction of the dwarf *Stegodon* and the giant tortoise *Geochelone* (Sondaar and Dermitzakis 1988:198). P. Bellwood (personal communication, 1990) believes that movement along the Lesser Sunda Islands would have been relatively easy during periods of low sea levels. Despite such narrow water gaps, only *Stegodon* and some of the rodents successfully made the crossing. The fossil and subfossil fauna of Flores shows a high level of endemism and little similarity to the Pleistocene fauna of Java (Groves 1985:46). While associations between the stone artifacts and *Stegodon* fossils may yet be demonstrated, there is no necessity for the association to date beyond the Upper Pleistocene.

Verhoeven also excavated a disturbing number of caves and rockshelters in West Flores, recovering a preceramic stone tool assemblage of primary flakes and crude bladelets. At Liang Toge, this assemblage was associated with a C^{14} date of 3550 ± 525 B.P. and fauna that included pig (van Heekeren 1972:141–142). Recent excavations by the National Research Center of Archaeology at Liang Bua should clarify the dating of stone artifacts from the preceramic layers at this site.

TIMOR

Stegodon fossils have been found in 11 locations in Timor. Ten of these are in the Atambua area near the center of the island, in a formation known as the Ainaro

gravels. Audley-Charles (quoted in Glover 1973b:122) describes this as "a stream-laid deposit almost certainly of late Middle to early Upper Pleistocene age which is now at 400 metres a.s.l., although the marine and estuarine shells in, and immediately below the deposit indicate that it was laid down close to sea level."

The associated artifacts, all from the gravel deposits at Atambua, are mostly surface finds from eroded gullies, though a few flakes and core tools are described as being "*in situ* in bone-bearing layers." They consist of a small number of choppers, but mostly unifacially retouched scrapers with jagged or convex working edges, made on flakes 9–15 cm long (Glover 1973b:125; see also Maringer and Verschuuren 1981).

Glover and Glover (1970:189) comment that the artifacts from these gravels are unlike those recovered from stratified shelter sites on Timor. "In recent excavations . . . cave deposits produced artefact and faunal assemblages going back over 13,000 years with neither *Stegodon* nor stone artefacts such as the ones described [above]. . . . The stone used in the cave industries is a fine non-crystalline flint quite different from the coarse chert used for the older, large flake tools."

SUMBAWA AND SUMBA

Core and flake tools have been collected from surface sites, mainly river gravels, on the island of Sumbawa by Soejono, who described them in general terms as part of a widespread industry. "The flakes and blades are simple in form, thick with a clear bulb of percussion, and with a wide striking platform, showing use retouch or primary retouch at the butt-end, enabling us to classify these as the Clactonian flake-blade type. The widespread massive tools are the chopper and chopping tool. Especially the horse-hoof-shaped chopper shows a wide distribution, as well as the side scraper" (Soejono 1982:27).

Sartono (1987:199, 206) reports stone artifacts belonging to the "chopper-chopping tool" tradition as being found on most of the islands of Nusatenggara, including Sumba, in Upper Pleistocene sediments.

The pygmy *Stegodon* from Sumba came as a chance find embedded within a hard calcified sandstone-and-gravel deposit in an ancient coast terrace of Quaternary age, which "had been cut into by an ancient river . . . indicated by the existence of a canyon-like dry valley." The fossil itself was found on the bed of this ancient river (Sartono 1979a:57).

In summary, perhaps it is best to follow Bellwood's (1987:186) caution as regards the age and association of the stone artifacts from Eastern Nusatenggara: "Scattered surface finds in the Lesser Sundas are known from Flores, Timor and Sumbawa and occur in possible but unproven primary association with bones of *Stegodon* in Flores. No convincing absolute dates can be presented."

Philippines

Most attention has been given to the presence of Cabalwanian pebble tools, including horse-hoof cores, on surface sites in the Cagayan Valley, Northern Luzon, in the Philippines (Fox 1978:69). However, Fox points out that 93 percent of the assemblages consist of flake artifacts. They are mostly small flakes with little secondary retouch and few diagnostic features capable of distinguishing them from those from the Upper Pleistocene Tabon Caves.

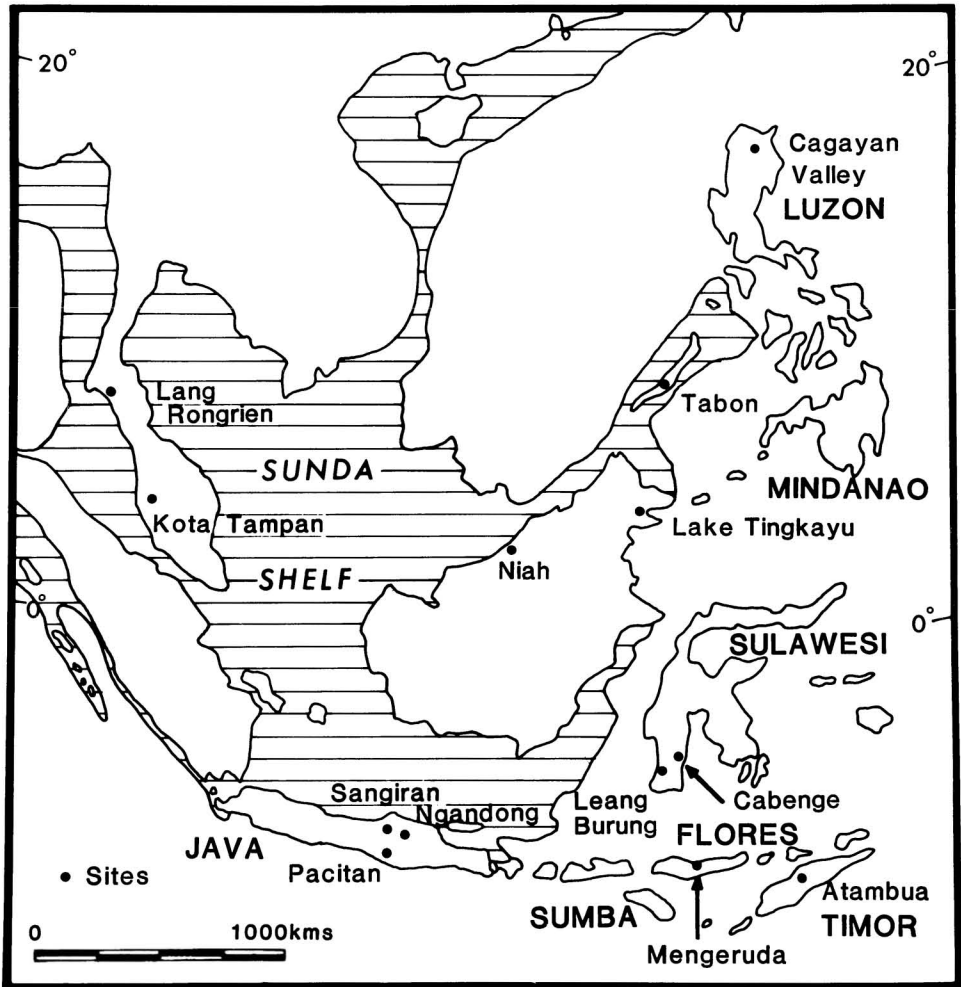


Fig. 2. Pleistocene fossil and archaeological sites in Southeast Asia. (After Bellwood 1985.)

Three excavations have been carried out to establish an in situ association between the stone implements and the fossil remains of extinct Pleistocene mammals—*Elephas*, *Stegodon*, and *Babalis*—recovered from the same geographical locality (Fox 1978:73–79). These excavations were at Espinosa Ranch, localities 1 and 4, and Madrigal, locality 12. While flakes and fossils occurred near each other, definite association between the two remained elusive.

Artifacts, both cobble tools and flakes, of essentially the same type as on the open sites, have been excavated from the nearby Penablanca Caves, dating from the Upper Pleistocene to Lower Holocene (11,500–2,000 B.P.) (Hutterer 1985:12; Wasson and Cochrane 1979:23). Finally, Wasson and Cochrane conclude that the fresh appearance of artifacts on the open sites suggests that they postdate the fossils. “Many of the stone tools and waste flakes have been found on knolls that are covered by lag gravels derived from gravel-rich sediments in the folded sequence. It is

possible that man was using these lag formations as quarries and that at least some of the tools are very much younger than the sediments in the anticlines" (1979:22).

Because of the presence of "continental" fauna, such as *Stegodon*, in the Philippines, it has been assumed that these islands must have been connected to the Sundaland continent via Taiwan and South China and ultimately to Sulawesi (Shutler and Braches 1987:185–186).

The faunal evidence from the Philippines has been reviewed by Heaney (1985:141), who concluded that "the geological and zoogeographic data . . . constitute a consistent and strong case for an absence of land bridges to the main body of the Philippines during, the Middle, or Late Pleistocene." Allowing a Middle Pleistocene land connection only between Palawan and Borneo, Heaney continues, "If *Homo erectus* occurred on Luzon, it arrived by dispersal over several sea channels."

Malaysia

Initially discovered in 1938, the site of Kota Tampan on the Perak River in Upper Perak was thought to contain typical artifacts of the chopper–chopping tool complex. These were flakes from crudely prepared cores, choppers, and crude hand-axes in Pleistocene tin-bearing gravels (Movius 1955:531).

The tools came from pebbles and gravels, part of a high river terrace or beach, which Walker related to a former higher sea level. Extrapolating from Walker's comments, de G. Sieveking suggested a date of "possible Late First Interglacial or more probably of early Second Glacial date" (Walker and de G. Sieveking 1962:111) and commented that this "gives the Tampanian a date as early or earlier than that of any other Palaeolithic industry in the Far East" (ibid., 120).

The age and appearance of the material from Kota Tampan led Sieveking to suggest that "it is possible that the Pebble and Flake cultures of Southern and Eastern Asia have their precursors in the African Oldowan as well as their related contemporaries in industries such as the Clactonian of Europe" (Walker and de G. Sieveking 1962:125).

The age and status of the Tampanian assemblage continued to be accepted in the archaeological literature until 1975. Harrisson, however, then reviewed the reliability of the geological basis of its dating and the typological assumptions that propped up its antiquity. He concluded,

This makes it initially unlikely (by no means impossible) that the stone tools are much later than 35,000 years. . . . Tampan may presently be . . . regarded, quite provisionally, as an early, crude form or precursor of Hoabinhian, overlapping in time the Niahian material from East Malaysia. . . . It would be possible . . . to look upon Tampan as perhaps an outdoor extension of the cave activity, with these gravels as workshop or alternative sources of tool supply, a little away from the easy shelter of the caves. (Harrisson 1975:66)

The workshop/quarry status of the Kota Tampan site has recently been confirmed by excavations and dates of c. 31,000 B.P. from associated felsic volcanic ash (Zuraina 1990; Tjia and Zuraina 1990).

Thailand

It is unfortunate that Middle Pleistocene flaked cobbles from Ban Mae Tha in Northern Thailand (Pope et al. 1986) are from fluvatile gravel deposits and are not

therefore definite artifacts. No unchallengeable association of extinct fauna with human remains or artifacts has yet been found anywhere in Thailand (Charoenwongsa and Bronson 1988:19, 21).

DISCUSSION

For the area west of Huxley's Line, there is little difficulty in accepting the chronological association of *Stegodon* fossils, small flakes and cores, and hominids at Ngandong and possibly at Sangiran. More problematical is the dating of the deposits. In opposition to Jacob's (1978:35) estimate of 300,000–900,000 B.P. for the Ngandong hominids, both Sartono (1987:195) and Bartstra et al. 1988:330) suggest an Upper Pleistocene age (30,000–100,000 B.P.) for the Solo High Terrace. If proved, the claims of Bartstra and colleagues would represent the youngest dates for the survival of both the *Stegodonts* and Ngandong Man. Furthermore if *Stegodon* could survive until 50,000–100,000 B.P. on Java, why not on the outer islands? Bartstra and colleagues (1988:335), however, clearly distinguish between the small flakes and cores present at Ngandong, deposited during the first half of the Upper Pleistocene, and the heavy flakes and core tools found at Pacitan. The latter, they argue, were produced during the second half of the Upper Pleistocene (50,000–10,000 B.P.).

East of Huxley's Line, claims for the antiquity of stone artifacts and, by implication, hominid occupation rest on one or more of the following strands of argument.

First, that the chopper–chopping tool complex was everywhere the product of *Homo erectus*. The distribution of these artifacts on many islands of the Southeast Asian archipelago was taken as evidence, therefore, that *H. erectus* was able to cross the watergaps of Wallacea during a period of lower sea level to settle those islands (Sartono 1987:199, 203, 209).

Second, that the artifacts, being similar to those recovered from Pacitan, were of similar, supposedly Middle Pleistocene, age (Glover 1973b:125).

Third, that the artifacts were associated with geological deposits and layers bearing *Stegodon* fossils, and were therefore assumed to date to the Late Middle to Early Upper Pleistocene (Glover 1973b:122).

Finally, that the artifacts were dissimilar to dated assemblages recovered from stratified shelter deposits, such as the flakes from Niah and Tabon caves (40,000–10,000 B.P.) (Glover 1973a:56); the scrapers, blades, and (few) Levallois points from Leang Burung 2 (30,000–19,000 B.P. [Glover 1981:12]); and even the core tool and scraper industries of Australia.

Glover (1973b:110) comments that “although these ancient core and scraper industries are difficult to characterize, . . . distinct differences can be seen between the Patjitianian and the old Australian tradition. This is, of course, not too surprising, since no Australian material can yet be dated to more than 30,000 B.P. . . . and the Patjitianian may be anything up to 500,000 years old, on present estimates.”

Taking these arguments in turn, it is possible to show that each is either wrong or weak in supporting evidence, or else that the evidence is equally capable of supporting an alternative hypothesis.

There is no direct evidence that *H. erectus* was ever present on the islands of Wallacea. Sartono's claims for the presence of Solo Man in Wallacea stem from the way he organizes the data; restricting *H. sapiens* to the early Holocene (1987:199)

makes *H. erectus* the only possible manufacturer of stone artifacts occurring in Pleistocene river gravels.

Of the Stegodont fossils relating to the Middle Pleistocene or earlier (Kali Glagah, Sangiran, Cabenge, Cagayan Valley), only those from Sangiran (west of Huxley's Line) are associated with Middle Pleistocene hominids. The claims for an association of the stone artifacts with the Stegodont faunas at Walanae (Cabenge) in Sulawesi, and at the Cagayan Valley in Luzon, can be discounted. In both cases the fossils predate the artifacts. The only other possible associations claimed for Wallacea are at Mengeruda in Flores, and Atambua in Timor. Proving or disproving these claims is now largely beside the point. There is consensus that the gravels and the artifacts, either included within them or lying as surface finds on them, belong to the Upper Pleistocene period (Bartstra 1982; Bartstra et al. 1988; Bellwood 1987:185–186; Glover 1973a:56; Sartono 1987:199, 203; Wasson and Cochrane 1979:22–23). The Stegodont fossils within these gravels may be the product of secondary deposition. If, however, the fossils and the gravels are contemporaneous and the stone artifacts turn out to be in situ, all this demonstrates is that *Stegodon* survived on these isolated islands until the middle part of the Upper Pleistocene only to meet an untimely end at the hands of an immigrant human population. This has a bearing on the important questions of Pleistocene extinctions and of the dating of the first arrival of humans on these islands, but it only tangentially concerns the status of the stone artifacts.

The dating of the extinctions of the Stegodonts on the various islands of Wallacea remains unknown. Drawing on the Australian experience (White and O'Connell 1982:92), the absence of *Stegodon* from Upper Pleistocene cave deposits (Gua Lawa and Wadjak on Java, Uai Bobo 2 on Timor, Leang Burung 2 on Sulawesi, and Niah Cave on Borneo) might not be an indication that the Stegodonts were extinct by the Upper Pleistocene, or that human activities, including direct predation, can be discounted as reasons for the extinctions.

Recently reported thermoluminescence (TL) dates from archaeological sites in Northern Australia suggest the arrival of modern humans there between 50,000 and 60,000 B.P. (Roberts et al. 1990:153–156). These dates have revived arguments about the identity of the first human colonists to arrive in Sahul, and about *Homo erectus*'s presence in Wallacea.

Palaeoanthropologists face a major problem: they have no evidence that *Homo sapiens* were living in Southeast Asia or Australia 60,000 years ago. . . . It is possible, though unlikely that the people who occupied the site in the Northern Territory were what the anthropologists call "pre-modern"—either early *Homo sapiens* or perhaps late representatives of the hominid species called *Homo erectus*. These are known to have lived in Java and mainland Asia for the previous 900,000 years or so. (Bunney 1990:12)

As far as the islands of Wallacea are concerned, opinion as regards *Homo erectus*'s water-crossing abilities remains conservative. It is argued that *Homo erectus* was limited to continental Sundaland during the Pleistocene.

As Jones (1989:753) notes, the oldest evidence for the presence of humans in Wallacea continues to come from Australia. On the basis of this, he concludes that "Wallace's Line was crossed reasonably late in the Pleistocene, but that once having happened, movement was rapid through the entire archipelago, onto the Sahul shelf itself, and even beyond to some of the large islands of the Southwest Pacific" (ibid., 754).

In the light of these claims, Bellwood would probably revise his dates for the colonization of Wallacea upwards to 50,000–70,000 B.P. However, in general his

(1978:57) comment still stands: "The finds are not closely dated, and *Stegodon* could have survived late in the isolation of eastern Nusatenggara, so that there is still no firm evidence that man crossed the Wallace line prior to about [50,000–70,000] years ago."

It is important to remember that the failure to find evidence for human occupation in Wallacea before the Upper Pleistocene does not tell us much about the Middle Pleistocene hominids on Sundaland. In particular, conclusions drawn from the failure to find stone tools associated with the Middle Pleistocene *H. erectus* at Sangiran, Java, are almost certainly premature.

Two hypotheses about the technological abilities of the Javan Pithecanthropines have recently been advanced to explain this failure. The first is that *H. erectus* manufactured only small crude flakes and that any larger cobbles, cores, and implements—i.e., the classic chopper–chopping tool complex—dates only from the Upper Pleistocene (Bartstra 1982; Bartstra and Basoeki 1989:243).

Our experience in Central Java leads us to believe that the chopper/chopping tool complex of Southeast Asia is considerably younger than is usually thought, most of the large core industries there belonging to the second half of the Upper Pleistocene and in some cases even to the Lower Holocene. . . . It was *H. sapiens* who then roamed the [Sangiran] area, collecting suitable cobbles from the eroding lahars to manufacture his heavy duty implements. By then *H. erectus* had long since disappeared from Java. (Bartstra and Basoeki 1989:243)

The second hypothesis is that the Javan *H. erectus* population was entirely bereft of lithic culture, and possibly of any technology whatsoever (Bowdler 1990).

Java during the Middle Pleistocene was only a small corner of Sundaland. In addition, there are only a few exposures of Middle Pleistocene strata on this highly volcanic island. Giving due acknowledgment to the thorough surveys carried out by Bartstra over the past 15 years, environmental, taphonomic, and ecological (activity areas?) factors are still insufficient to explain the absence of stone implements from the Middle Pleistocene layers at Sangiran.

While never common, Middle Pleistocene hominids and stone artifacts, occasionally in association, occur throughout Central and Eastern Asia with dates ranging from 0.95 mya at Nihewan (Keates 1990), to c. 0.15 mya at Narmada (Kennedy 1990) and Tadzhikistan (Davis 1986), in addition to the better known Zhoukoudian and other Chinese sites (Brooks and Wood 1990:288).

Circumstances at these sites vary. In terms of stone artifacts, they range from an absence of any at all, to the presence of flakes, bipolar cores, and the occasional use of cobbles as cores, and finally, to sites where flaked cobbles or quartzite blocks are common. Brooks and Wood (1990:289) see *H. erectus* as possessing an expedient technology based on the widespread use of poor quality raw materials. Without wishing to resurrect the specter of the "chopper–chopping tool complex," it is clear that expedient use of blocks and cobbles has occurred throughout the Middle and Upper Pleistocene. If the Javan Pithecanthropines failed to make use of cobbles and blocks, the explanation is almost certainly circumstantial rather than a matter of technological competence or other population-specific behavior pattern.

Debate continues about the status and chronology of the chopper–chopping tool complex in Asia, and its relationship to the flake industries. Yi and Clark (1983), and Ayres and Rhee (1984) argue that true hand-axes are present in North Asia at least. Watanabe (1985) interprets the chopper–chopping tool complex as an adaptation to

life in the rainforest. Bailey and colleagues (1989) make a similar claim for the Hoabinhian but restrict specialized rainforest existence to the post-Pleistocene era. Finally, Ohel (1983) claims that the core tools of the chopper-chopping tool complex and the Pleistocene flake assemblages are simply two aspects of a single technological tradition. Clearly Movius's hypothesis of the chopper-chopping tool complex remains alive and well in recent archaeological debates and literature. It is to be hoped, however, that the days when the discovery of stone artifacts in the gravel terraces of Southeast Asia meant the automatic assumption of a Middle Pleistocene age are now over.

Four alternative theories could explain the differences between the Pacitanian-like large cores and flakes found on the gravel terraces at Pacitan and Walanae, and in Flores and Timor, and the late Pleistocene flake and scraper assemblages recovered from sediments in rockshelters at Niah, Leang Burung 2, and Uai Bobo 2, dated between 7000 and 30,000 B.P.

The first hypothesis is that the Pacitanian-like artifacts are older than the shelter deposits, perhaps as old as 50,000–70,000 B.P. They would, therefore, represent an early or ancestral stage in the development of the region's Late Pleistocene stone artifact assemblages (Glover 1981:37).

The second concerns the areas where archaeologists have concentrated their activities. The differences between Late Pleistocene stone artifacts recovered from rockshelters and the core and flake tools found on the river terraces have led archaeologists to claim that human occupation of rockshelter sites began only during the Upper Palaeolithic or Mesolithic period (12,000–40,000 B.P.) (van Heeckeren 1972:10; Soejono 1982:28). This expectation has led to a neglect of the rockshelter sites in the Pacitan region, to assumptions of a recent age for all materials recovered from stratified shelter sites, and to assumptions of great antiquity for all artifacts from gravel exposures.

The third hypothesis is that the excavated assemblages and the flake and pebble tools from the terrace gravels date from the same time period. The different assemblages might be functionally differentiated, with the open terrace sites representing quarries and raw material sources, while the shelters functioned as living areas where smaller stone artifacts were manufactured and used (Harrison 1975:66; Hutterer 1985:16). Bartstra (1982:319) notes that "it is truly questionable to what extent the various sites of the Patjitanian culture represent only different seasonal or occupational activities of a group of (sub-) Holocene hunter-gatherers. Wajak man could very well have been the manufacturer of the Patjitanian tools."

Finally, there is the argument that the large-core tool and flake assemblages overlap in time with the excavated Late Pleistocene assemblages. In this case, the excavated assemblages dating between 7000 and 30,000 B.P. should be regarded as unrepresentative of the full range of stone artifact assemblages present in the Southeast Asian region during the Upper Pleistocene (Bartstra et al. 1988:335).

Recent discoveries do provide evidence that the present knowledge of Asian Pleistocene assemblages is inadequate. Such discoveries include, first, a unique assemblage of "large fist-sized bifaces, some of fully edged hand-axe shape, and smaller finely flaked forms which appear to have served combined functions as points and knives," discovered by Bellwood at Lake Tingkayu in Eastern Sabah, and dated between 17,000 and 28,000 B.P. (Bellwood 1987:195–196).

Second, Anderson's excavation of a pre-Hoabinhian assemblage of carefully re-

touched flakes and a few core tools which date from 27,000 to 37,000 B.P. at Lang Rongrien, Southern Thailand (Anderson 1987:185–198), further modifies the traditional view of artifact succession in Southeast Asia.

Surprisingly, few of the Pleistocene implements are pebble tools, . . . to date, interpretations of the early prehistory of Southeast Asia are largely based on ideas developed by Hallam Movius. . . . Movius concluded that the original tool-making industry of East and Southeast Asia centred on the manufacture of large pebble tools. . . . Finds from Lang Rongrien suggest that the . . . theory must now be reevaluated. . . . the majority of the Lang Rongrien artifacts are made from flakes. Furthermore, the Lang Rongrien artifacts are generally similar in workmanship to late Paleolithic flake implements from both China and South Sulawesi. They are not at all what would be expected of a proto-Hoabinhian technology. (Anderson 1987:193–195)

In addition, there is the variability of the Pleistocene assemblages of Sahulland (Australia and Papua New Guinea), which range from the large cores and scrapers at the Mungo 1 site (Bowler et al. 1970), the edge-ground axes and flake assemblages of Arnhem Land (Allen and Barton 1989), and the waisted axes and miscellaneous scraper assemblages of New Guinea (White 1969; White and Allen 1980:730), to the flake and thumbnail scraper assemblages of Pleistocene Highland Tasmania (Cosgrove 1989:1710). Clearly the Australian “Core Tool and Scraper Tradition” identified by Jones and Allen at the Mungo 1 site (Bowler et al. 1970:52) should be regarded as one tradition among many present in Australia during the Late Pleistocene. It should not be seen as representing a chronological stage of development, an artifact horizon, or even an artifact assemblage that was common to all Australian regions at any time in the past (cf. Allen et al. 1989:552–554, 559). The different regions of Sahulland, like Island Southeast Asia, follow Glover’s (1979:173) generalization that localized areas have typological traditions that persist through time within each area, with little impact on adjacent regions.

Notwithstanding these differences, it is clear that much of the perceived variation in stone artifact assemblages across Sunda and Sahulland during the Upper Pleistocene is a function of raw material availability, variations in the tasks performed at each site, and biased collection strategies on the part of archaeologists.

At a higher level of generalization, it can be seen that the stone artifacts of Southeast Asia belong to the same technological tradition as those from New Guinea and Australia.

Within Australia and Tasmania all the tool type preforms used throughout the last 40,000 years were produced from a single reduction sequence. Lithic raw materials were selected and reduced, solely by percussion techniques, into a variety of flakes and blades. . . . a highly *opportunistic* use of stone in Australia is congruent with our other information about stone tools. . . . pieces of stone [were] selected for their intended task, rather than designed and made to a regular formal pattern. (Flenniken and White 1985:131–132)

To conclude, the spread of humans across Wallacea, onto the Australian continent, and into diverse and extreme habitats, and across further watergaps of at least 170 km to Buka in the Solomon Islands (Wickler and Spriggs 1988:703) appears to have begun during the early part of the Upper Pleistocene. Since it was substantially completed by c. 40,000 B.P., it was a very rapid event.

Stone tools, however, can tell us only part of the story, as Jones (1989:755) points out:

In the period just prior to the colonisation of Australia—say 40 kyr ago—there were people living on the shores of Sundaland, in the mangrove swamps and using river mouth resources. They had an adequate technology of inshore watercraft, perhaps rafts made of bamboo palm or other suitable materials. Random events such as storms and currents sometimes swept people off into the ocean, where under suitable conditions of wind and current they made new land falls.

AFTERWORD

A great deal of progress has been made and new evidence has become available for Southeast Asia over the past 10 years. Much of the credit for this must go to individuals like G. J. Bartstra and also to the Indonesian National Research Center of Archaeology, working with the Biological-Archaeological Institute, Groningen, and the Institute of Human Palaeontology, Paris. Excavations carried out by the National Research Center at Liang Bua, Flores, and at Camplong near Kupang, Timor, and the proposed excavations at Song Agung, Pacitan, will do much to fill in the gaps and cause further revision of the picture presented above.

Hutterer's prescription for Southeast Asian Archaeology is that "it is essential to describe qualitative and quantitative aspects of assemblage composition and variability carefully and in detail, to investigate the taphonomic processes that may have affected assemblage composition, and to interpret assemblage variability in the context of settlement organization and site formation process" (1985:17).

Such strategies require a tactical change in approach away from the single-site, small-scale, limited-duration projects that have been the norm in Southeast Asia until now. Within Indonesia, joint-funded, longer term projects based at Indonesian universities or the National Research Institute might represent an equitable way to proceed, a way out of the impasse created by long distance theories and theoreticians.

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REFERENCES

- AIGNER, J. S.
1978 Pleistocene faunal and cultural stations in South China, in *Early Paleolithic in South and East Asia*: 129–162, ed. F. Ikawa-Smith. The Hague: Mouton.
- ALLEN, H., AND G. BARTON
1989 *Ngarradj Warde Djibkeng: White Cockatoo Dreaming and the Prehistory of Kakadu*. Oceania Monographs 37. Sydney: Oceania Publications.
- ALLEN, J., C. GOSDEN, AND J. PETER WHITE
1989 Human Pleistocene adaptations in the tropical island Pacific: Recent evidence from New Ireland. *A* 240:548–561.
- ANDERSON, D.
1987 Lang Rongrien, a Pleistocene rock shelter, Thailand. *National Geographic Research* 3:185–198.

- AYRES, W.S., AND S.N. RHEE
The Acheulian in Asia: A review of Research on Korean Palaeolithic Culture. *Proceedings of the Prehistoric Society* 50:35-48.
- BAILEY, R. C., G. HEAD, M. JENIKE, B. OWEN, R. RECHTMAN, AND E. ZECHENTER
1989 Hunting and gathering in tropical rainforest: Is it possible? *AA* 91:59-82.
- BARTSTRA, G. J.
1976 *Contributions to the Study of the Palaeolithic Patjitan Culture Java, Indonesia*. Part 1. Leiden: E. J. Brill.
1978a Note on new data concerning the fossil vertebrates and stone tools in the Walanae Valley in South Sulawesi. *MQRSEA* 4:71-72.
1978b Recent palaeolithic research in Java: The first six months of a new project. *MQRSEA* 4:63-70.
1982 *Homo erectus erectus*: The search for his artifacts. *CA* 23:318-320.
- BARTSTRA, G. J., AND BASOEKI
1989 Recent work on the Pleistocene and Palaeolithic of Java. *A* 30:241-244.
- BARTSTRA, G. J., BASOEKI, AND B. SANTOSA AZIS
1976 Solo Valley research 1975: Java, Indonesia. *MQRSEA* 2:23-36.
- BARTSTRA, G. J., S. SOEGONDHO, AND A. VAN DER WIJK
1988 Ngandong Man: Age and artifacts. *Journal of Human Evolution* 17:325-337.
- BELLWOOD, P.
1978 *Man's Conquest of the Pacific*. Auckland: Collins.
1985 *Prehistory of the Indo-Malaysian Archipelago*. Sydney: Academic Press.
1987 The prehistory of Island Southeast Asia: A multidisciplinary review of recent research. *Journal of World Prehistory* 1:171-223.
- BOWDLER, S.
1990 The earliest Australian stone tools and implications for Southeast Asia. Paper presented to the fourteenth Congress of the Indo-Pacific Prehistory Association, Yogyakarta, Indonesia.
- BOWLER, J. M., R. JONES, H. ALLEN, AND A. G. THORNE
1970 Pleistocene human remains from Australia: A living site and human cremation from Lake Mungo, western New South Wales. *WA* 2:39-60.
- BROOKS, A. S., AND B. WOOD
1990 The Chinese side of the story. *Nature* 344:288-289.
- BUNNEY, S.
1990 First Australians "were earliest seafarers." *New Scientist* (May 19): 12.
- CHAROENWONGSA, P., AND B. BRONSON, (EDS.)
1988 *Prehistoric Studies: The Stone and Metal Ages in Thailand*. Papers in Thai Antiquity, Vol. 1. Bangkok: Thai Antiquity Working Group.
- COSGROVE, R.
1989 Thirty thousand years of human colonization in Tasmania: New Pleistocene dates. *S* 243:1706-1708.
- DAVIS, R. S.
1986 The Soan in Central Asia? Problems in lower paleolithic culture history, in *Studies in the Archaeology of India and Pakistan* 1: 17, ed. J. Jacobson. New Delhi: Oxford University Press and IBH.
- FLENNIKEN, J. J., AND J. P. WHITE
1985 Australian flaked stone tools: A technological perspective. *Records of the Australian Museum* 36:131-151.
- FOLEY, R.
1987 Hominid species and stone-tool assemblages: How are they related? *A* 61:380-392.
- FOX, R. F.
1978 The Philippine Paleolithic, in *Early Paleolithic in South and East Asia*: 59-86, ed. F. Ikawa-Smith. The Hague: Mouton.
- GLOVER, I. C.
1973a Late Stone Age traditions in South-East Asia, in *South Asian Archaeology*: 51-66, ed. N. Hammond. London: Duckworth.

- 1973b Island Southeast Asia and the settlement of Australia, in *Archaeological Theory and Practice*: 105–129, ed. D. E. Strong. London: Seminar Press.
- 1979 The Late Prehistoric period in Indonesia, in *Early South East Asia*: 167–184, ed. R. B. Smith and W. Watson. New York: Oxford University Press.
- 1981 Leang Burung 2: An upper palaeolithic rock shelter in South Sulawesi, Indonesia. *MQRSEA* 6:1–38.
- GLOVER, I. C., AND E. A. GLOVER
1970 Pleistocene flaked stone tools from Timor and Flores. *Mankind* 7:188–190.
- GROVES, C. P.
1985 Plio-Pleistocene mammals in Island Southeast Asia. *MQRSEA* 9:43–54.
- HARRISON, TOM
1975 Tampan: Malaysia's Palaeolithic reconsidered. *MQRSEA* 1:53–70.
- HEANY, L.
1985 Zoogeographic evidence for Middle and Late Pleistocene land bridges to the Philippine Islands. *MQRSEA* 9:127–143.
- HEEKEREN, H. R. VAN
1958 The Tjabenge flake industry from South Celebes. *AP* 2:77–81.
1972 *The Stone Age of Indonesia*. 2nd rev. ed. The Hague: Martinus Nijhoff.
- HOANG, XUAN CHINH
1990 The faunal and cultural changes from Pleistocene to Holocene in Vietnam. Paper presented to the Fourteenth Congress of the Indo-Pacific Prehistory Association, Yogyakarta, Indonesia.
- HOOIJER, D. A.
1975 Quaternary mammals west and east of Wallace's Line. *MQRSEA* 1:37–46.
1981 What, if anything new, is *Stegodon sumbaensis* Sartono? *MQRSEA* 6:89–90.
1982 The extinct giant land tortoise and the pygmy *Stegodont* of Indonesia. *MQRSEA* 7:171–176.
- HUTTERER, K. L.
1977 Reinterpreting the Southeast Asian Palaeolithic, in *Sunda and Sahul: Prehistoric Studies in South-east Asia, Melanesia and Australia*: 31–72, ed. J. Allen, J. Golson, and R. Jones. London: Academic Press.
1985 The Pleistocene archaeology of Southeast Asia in regional context. *MQRSEA* 9:1–23.
- JACOB, T.
1978 The puzzle of Solo Man. *MQRSEA* 4:31–40.
- JACOB, T., R. P. SOEJONO, L. G. FREEMAN, AND F. H. BROWN
1978 Stone tools from Mid-Pleistocene sediments in Java. *S* 202:885–887.
- JONES, R.
1989 East of Wallace's Line: Issues and problems in the colonisation of the Australian continent, in *The Human Revolution*: 743–782, ed. P. Mellars and C. Stringer. Edinburgh: University of Edinburgh Press.
- KEATES, S. G.
1990 Aspects of palaeoenvironment and hominid behaviour in the Nihewan basin, Northern China. Paper presented to the Fourteenth Congress of the Indo-Pacific Prehistory Association, Yogyakarta, Indonesia.
- KENNEDY, K. A. R.
1990 The fossil hominid from the Narmada Valley, India: *Homo erectus* or *Homo sapiens*? Paper presented to the Fourteenth Congress of the Indo Pacific Prehistory Association, Yogyakarta, Indonesia.
- MARINGER, J., AND TH. VERHOEVEN
1970a Die steinartefakte aus der *Stegodon*-fossilschicht von Mengeruda auf Flores, Indonesien. *Anthropos* 65:229–247.
1970b Die oberflächenfunde aus dem fossilgebeit von Mengeruda und Olabula auf Flores, Indonesien. *Anthropos* 65:530–546.
1972 Steingerate aus dem Waiklau trockenbett bei Maumere auf Flores, Indonesien. *Anthropos* 67:129–137.
1975 Die oberflächenfunde von Marokoak auf Flores, Indonesien. *Anthropos* 70:97–104.
- MARINGER, J., AND J. VERSCHUUREN
1981 Zum Palaolithikum der Insel Timor, Indonesien. *Anthropos* 76:584–588.

- MEDWAY, LORD
1972 The quaternary mammals of Malesia: A review, in *The Quaternary Era in Malesia*: 63–83, ed. P. and M. Ashton. Miscellaneous Series 13. Hull: Department of Geography, University of Hull.
- MOVIUS, H. L., JR.
1955 Palaeolithic archaeology in Southern and Eastern Asia, exclusive of India. *Journal of World History* 2:257–282, 520–553.
- MULVANEY, D. J.
1970 The Patjitanian industry: Some observations. *Mankind* 7:184–187.
- OHEL, M. Y.
1983 On observations on the lower Palaeolithic of Northeast Asia. *CA* 24:665.
- POPE, G. G., S. BARR, A. MACDONALD, AND S. NAKABANLANG
1986 Earliest radiometrically dated artifacts from Southeast Asia. *CA* 27:275–279.
- ROBERTS, R. G., R. JONES, AND M. A. SMITH
1990 Thermoluminescence dating of a 50,000 year-old human occupation site in northern Australia. *Nature* 345:153–156.
- SARTONO, S.
1979a The discovery of a pygmy *Stegodon* from Sumba, East Indonesia: An announcement. *MQRSEA* 5:57–64.
1979b The age of the vertebrate fossils and artefacts from Cabenge in South Sulawesi, Indonesia. *MQRSEA* 5:65–81.
1979c The stratigraphy of the Sambungmacan site, Central Java. *MQRSEA* 5:83–88.
1987 The long trek to the south, in *Proceedings of the Workshop on Economic Geology, Tectonics, Sedimentary Processes and Environment of the Quaternary in Southeast Asia*: 193–212. Bangkok: Department of Geology, Chulalongkorn University.
- SEMAH, F., A. M. SEMAH, AND T. DJUBIANTONO
1990 *They Discovered Java*. Jakarta and Paris: Pusat Penelitian Arkeologi Nasional and Musee National d'Histoire Naturelle.
- SHUTLER, R., AND F. BRACHES
1985 Problems in paradise: The Pleistocene of Java revisited. *MQRSEA* 9:87–97.
1987 The palaeoanthropology of Pleistocene Island Southeast Asia: A review, in *Proceedings of the Workshop on Economic Geology, Tectonics, Sedimentary Processes and Environment of the Quaternary in Southeast Asia*: 185–191. Bangkok: Department of Geology, Chulalongkorn University.
- SIMPSON, G. G.
1977 Too many lines: The limits of the Oriental and Australian zoogeographic regions. *Proceedings of the American Philosophical Society* 121:107–120.
- SOEJONO, R. P.
1982 Trends in prehistoric research in Indonesia. *MQRSEA* 7:25–31.
- SONDAAR, P. Y.
1981 The *Geochelone* faunas of the Indonesian Archipelago and their paleogeographical and biostratigraphical significance. *MQRSEA* 6:111–120.
- SONDAAR, P. Y., AND M. D. DERMITZAKIS
1988 Colonization of islands by early man and its effect on the environment. *Modern Geology* 13:198–202.
- STRINGER, C.
1990 The Asian connection. *New Scientist* 17 (September): 23–27.
- TJIA, H. D., AND M. ZURAINA
1990 Physical environment of the Kota Tampan palaeolithic workshop (Malaysia). Paper presented to the Fourteenth Congress of the Indo-Pacific Prehistory Association, Yogyakarta, Indonesia.
- DE VOS, J., AND P. SONDAAR
1982 The importance of the Dubois Collection reconsidered. *MQRSEA* 7:35–63.
- WALKER, D., AND A. DE G. SIEVEKING
1962 The palaeolithic industry of Kota Tampan, Perak, Malaya. *Proceedings of the Prehistoric Society* 28:103–139.

- WASSON, R. J., AND R. M. COCHRANE
1979 Geological and geomorphological perspectives on archaeological sites in the Cagayan Valley, Northern Luzon, the Philippines. *MQRSEA* 5:1-26.
- WATANABE, H.
1985 The chopper-chopping tool complex of Eastern Asia: An ethnoarchaeological-ecological reexamination. *Journal of Anthropological Archaeology* 4:1-18.
- WHITE, J. P.
1969 Typologies for some prehistoric flaked stone artefacts of the Australian New Guinea Highlands. *APAO* 4:18-46.
- WHITE, J. P., AND J. ALLEN
1980 Melanesian prehistory: Some recent advances. *S* 207:728-734.
- WHITE, J. P., AND J. F. O'CONNELL
1982 *A Prehistory of Australia, New Guinea, and Sabah*. Sydney: Academic Press.
- WICKLER, S., AND M. SPRIGGS
1988 Pleistocene human occupation of the Solomon Islands. *A* 62:703-706.
- WOLPOFF, M. H., WU XINZHI, AND A. G. THORNE
1984 Modern *Homo sapiens* origins: A general theory of hominid evolution involving the fossil evidence from East Asia, in *The Origins of Modern Humans: A World Survey of the Fossil Evidence*: 411-483, ed. F. H. Smith and F. Spencer. New York: Alan R. Liss.
- YI, W., AND G. A. CLARK
1983 Observations on the lower Palaeolithic of Northeast Asia. *CA* 24:181-202.
- ZHANG, YINYUN
1990 Human fossils from Anhui, SE China: Coexistence of *Homo erectus* and *Homo sapiens*. Paper presented to the Fourteenth Congress of the Indo-Pacific Prehistory Association, Yogyakarta, Indonesia.
- ZURAINA, M.
1990 The Tampanian problem resolved: Archaeological evidence of a late Pleistocene lithic workshop. *MQRSEA* 11:71-96.